NIST Fingerprint Testing and Standards

http://fingerprint.nist.gov

February 28, 2013

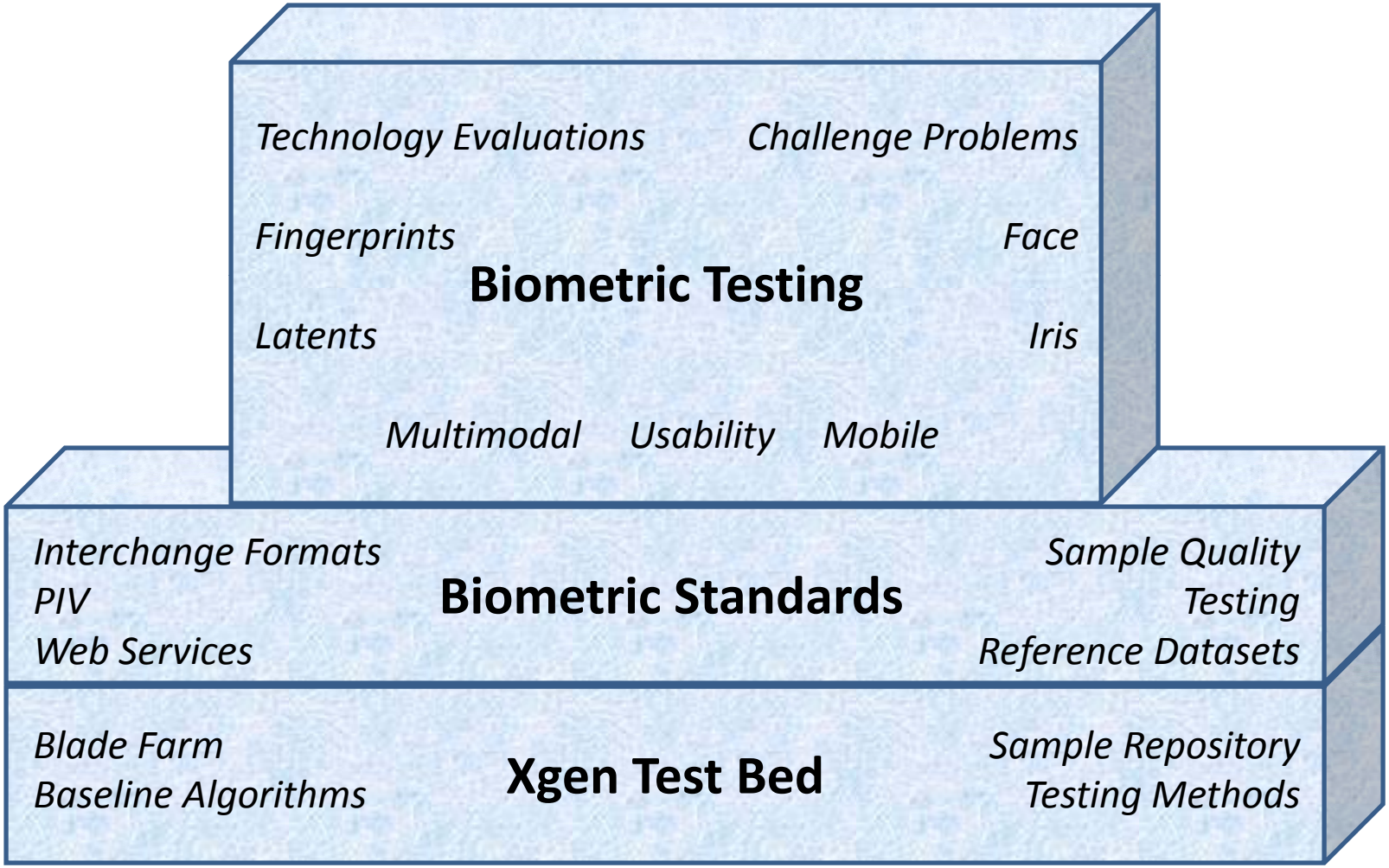
National Institute of Standards and Technology
U.S. Department of Commerce

INFORMATION TECHNOLOGY LABORATORY

A Rich History in Biometrics @ NIST

- Late 60's & 70's - Worked with the FBI to develop the first electronic fingerprint matching technologies
- Mid 80's – Developed first fingerprint data exchange standard (latest update: ANSI/NIST-ITL 1-2011)
- 90's – Began challenge problems and open evaluations of face recognition technologies (FERET→FRGC→FRVT)
- Tragic Events of 9-11
  (took ITL's biometrics relevance and work to a whole new level)
  - USA PATRIOT ACT
  - Enhanced Border Security and VISA Entry Reform Act

Biometrics Program



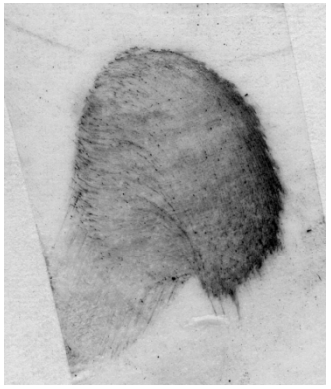
NIST/ITL/IAD: Biometrics

Contacts:

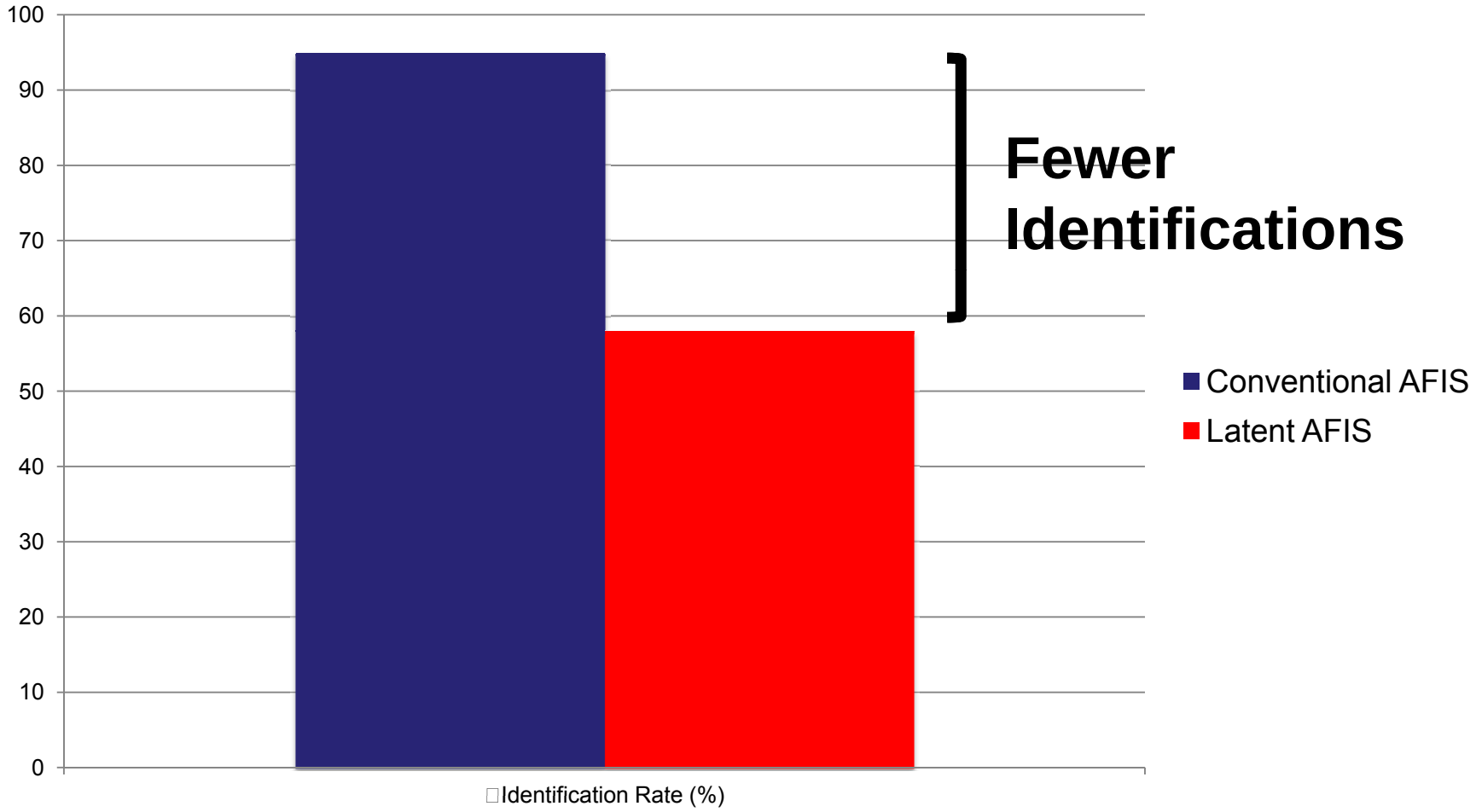
- Michael Garris (mgarris@nist.gov) – Image Group Leader
  http://www.nist.gov/itl/iad/ig/
- Brad Wing (bwing@nist.gov) – ANSI/NIST ITL Biometric Interchange Standard
  http://www.nist.gov/itl/iad/ig/ansi_standard.cfm
- Elham Tabassi (tabassi@nist.gov) – Biometric Sample Quality
  http://www.nist.gov/itl/iad/ig/bio_quality.cfm
- Shahram Orandi (shahram.orandi@nist.gov) – Latent Fingerprint Testing
  http://www.nist.gov/itl/iad/ig/latent.cfm
- Patrick Grother (pgrother@nist.gov) – Iris Testing & Standards
  http://www.nist.gov/itl/iad/ig/irex.cfm
- Craig Watson (cwatson@nist.gov) – Biometrics Lab Manager
  http://www.nist.gov/itl/iad/ig/biometrics-test-lab.cfm
- Ross Micheals (rossm@nist.gov) – Biometric Web Services
  http://www.nist.gov/itl/iad/ig/bws.cfm
- Mary Theofanos (mary.theofanos@nist.gov) – Biometric Usability
  http://zing.ncsl.nist.gov/biousa/

NIST Evaluation of Latent Fingerprint Technologies

Shahram Orandi
NIST ITL



Latent AFIS Technology Gaps: Relatively Low Accuracy

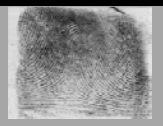
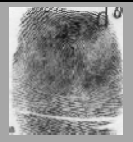
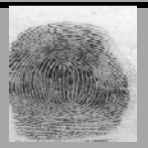
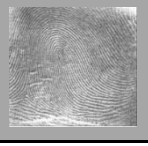


Latent Examiner

Latent image (+ features) "Search"

AFIS

Potential matches

Rank	Candidate
1	
2	
3	
...	
20	

Latent AFIS Technology Gaps

- **Relatively low accuracy**
  - 65-70% identification rate considered “high performance”
- **High manual workload**
  - features selection & markup (~15 min/latent)
  - candidate list evaluation (~ 20 candidates/search)

Approach: (i) Open Evaluation & Testing of core search algorithms (image- and feature-based) using operational data ; (ii) Metrics for matcher performance and workload reduction capabilities ; (iii) Factors affecting poor performance; (iv) Techniques to boost accuracy ; (v) Reference data

What is ELFT?

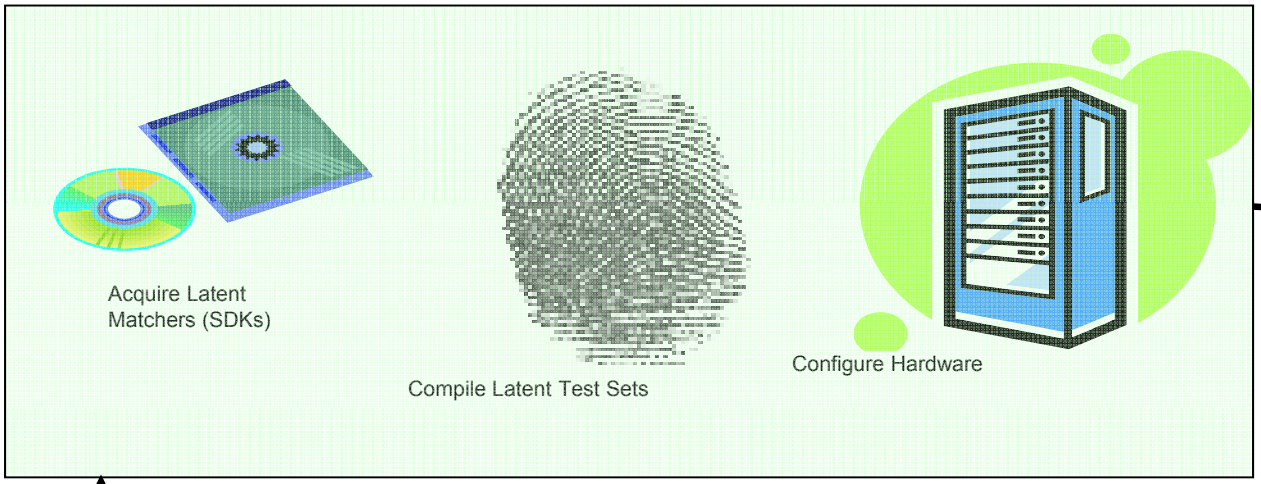
- Large-scale open evaluation of automated latent fingerprint identification systems (AFIS) using automatic feature extraction and matching (AFEM) and standardized features hand-marked by human experts.

- Interactive effort between NIST and latent AFIS community to improve accuracy, promote interoperability, and reduce reliance on human examiners.

ELFT History

- 2006 — NIST Latent Fingerprint Testing Workshop
- 2007 — **ELFT Phase I Evaluation**
- 2008 — **ELFT Phase II Evaluation**
- 2009 — NIST Latent Fingerprint Testing Workshop
  ELFT Phase II Miss Analysis Sessions
  ELFT-EFS Public Challenge
- 2010 — **ELFT-EFS Evaluation #1**
  ELFT-EFS Miss Analysis Sessions
- 2011 — **ELFT-EFS Evaluation #2**

NIST Evaluation of Latent Fingerprint Technologies (ELFT)



Evaluation Protocol

- **Execute 1-to-Many searches**
  - **Image-only searches**
  - **Examiner-assisted searches (image + feature markup)**
  - **Operational images**
  - **Extended Feature Sets**
- **Measure & Analyze Results**
  - **Accuracy**
  - **Selectivity**
  - **Resource requirements**
  - **Gap analysis**

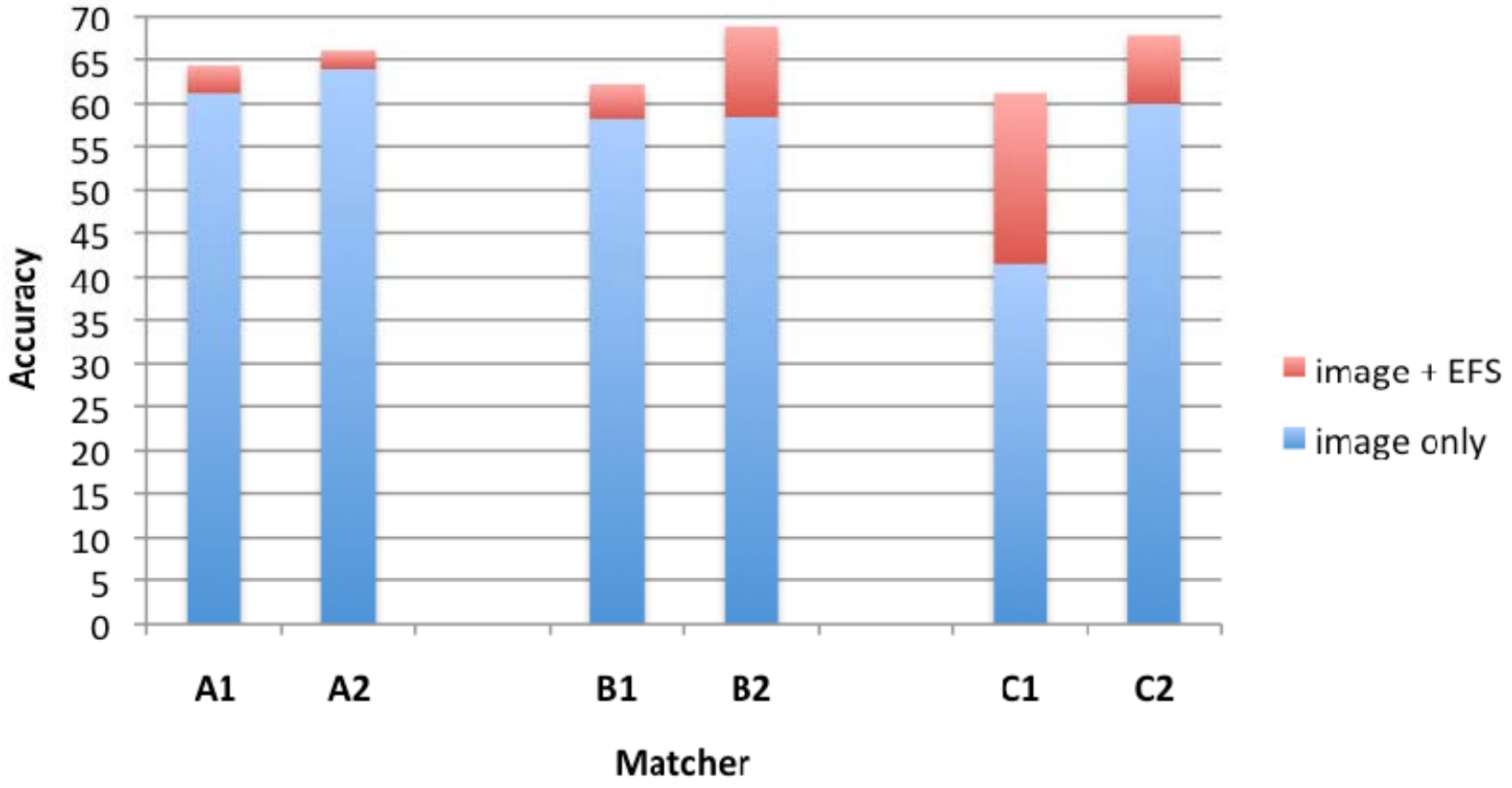
1. **Evaluation Reports**
2. **Feedback to Standardization**
3. **Technological Gap Analysis**
4. **Reference Data**

Iterate process

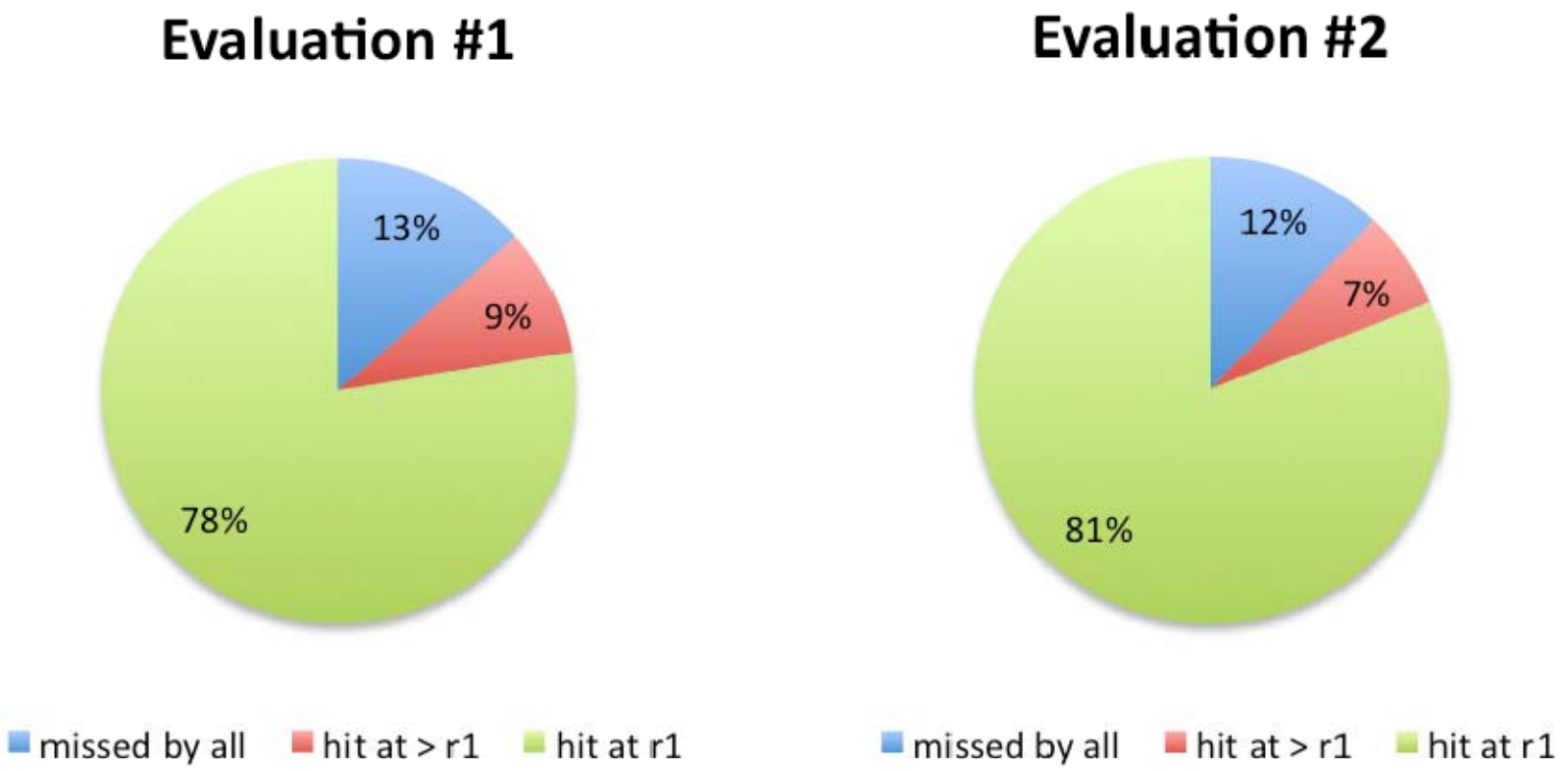
EFS Evaluation & Testing

- **ELFT-EFS Evaluation #1**
  - 1st Multi-vendor AFIS matcher evaluation using a common feature set (EFS)
  - Features defined by upcoming ANSI/NIST-ITL 2011 standard
  - Feature marked by experienced latent examiners using a common guidelines
  - Assesses the performance of latent AFIS search technology with:
    - ✓ minutiae only
    - ✓ image only
    - ✓ image + *various subsets of* EFS
  - Final Report: **NISTIR 7775**, March 2011
- **ELFT-EFS Evaluation #2**
  - Re-iteration of Evaluation #1 with updated algorithms
  - Follows miss analysis sessions conducted with developers
  - Measures improvements/regressions in matcher performance
  - Provides better estimate of state of the art
  - Final Report Q1 2012

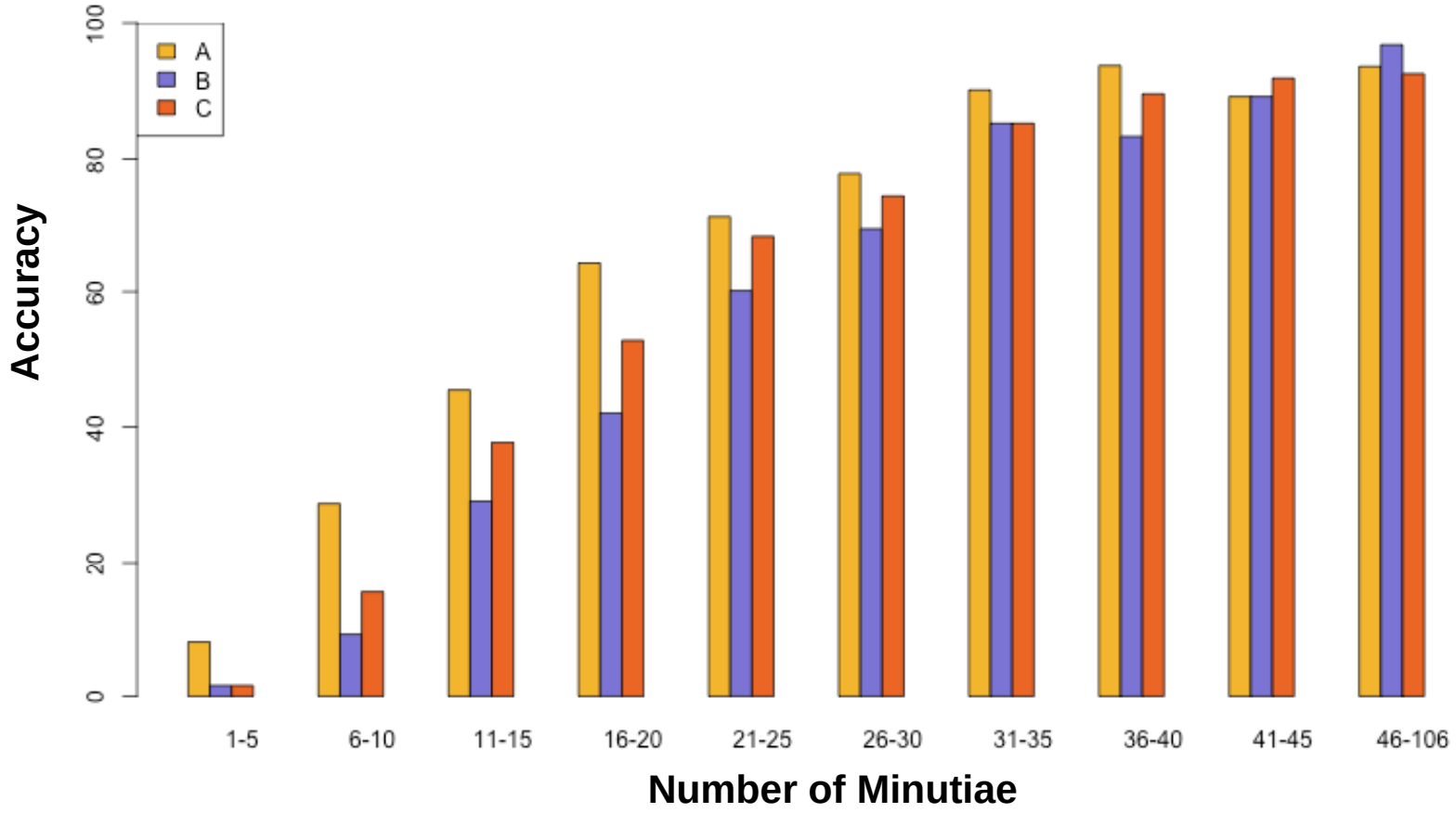
ELFT-EFS Results:
Accuracy Improvement (Eval 1 vs. 2)



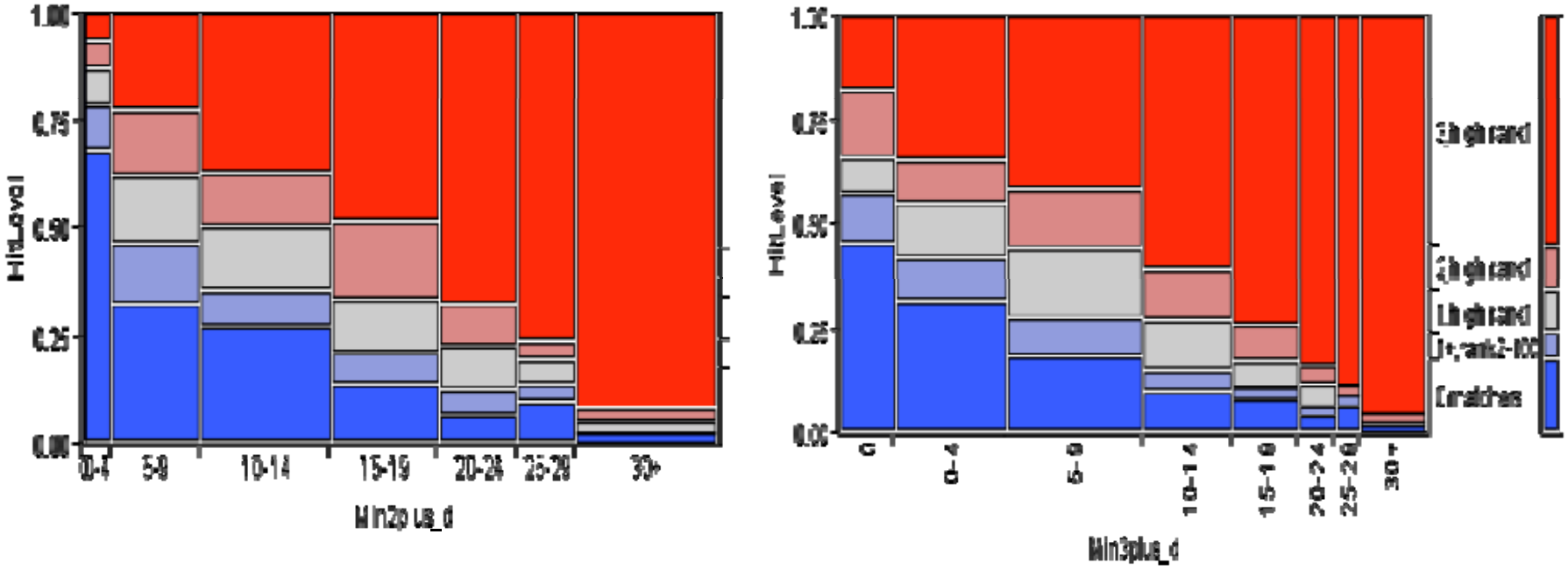
Collective Matcher Performance (1,114 latents)



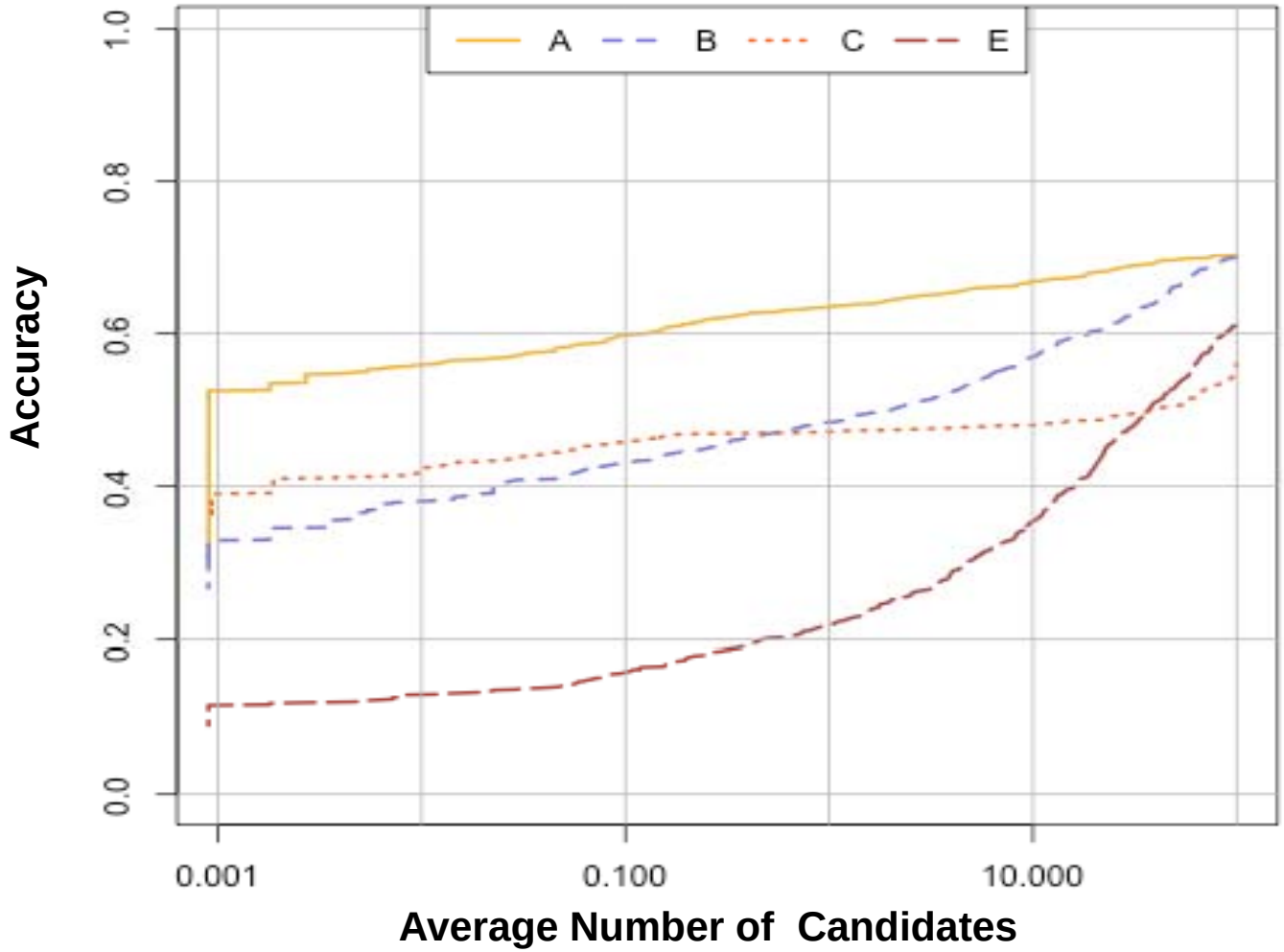
ELFT-EFS Results:
Accuracy vs. Minutiae Count



ELFT-EFS Results:
Accuracy vs. Minutiae + Quality



ELFT Results:
Accuracy vs. Workload



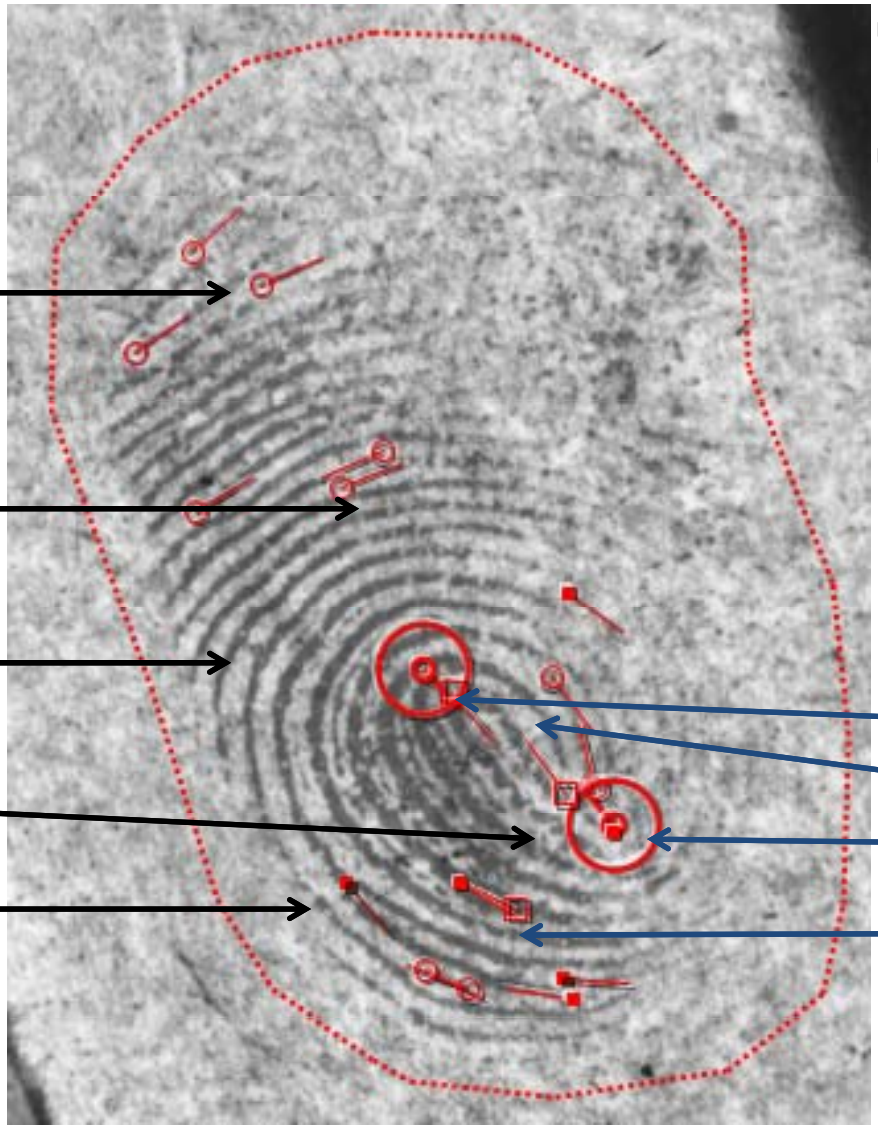
Latent AFIS Interoperability Problems

- **Lack of cross-jurisdictional interconnectivity**
  - technological differences
  - lack of exchange processes/agreements
  - funding issues, usage policies, legal issues, …
- **Differing features and data encodings**
  - manual feature selection is the norm
  - all commercial AFIS use proprietary features & encodings
  - (even common/"standardized" features differ between AFIS)
  - additional searches=re-selecting & re-encoding features

Latent AFIS Interoperability Solutions

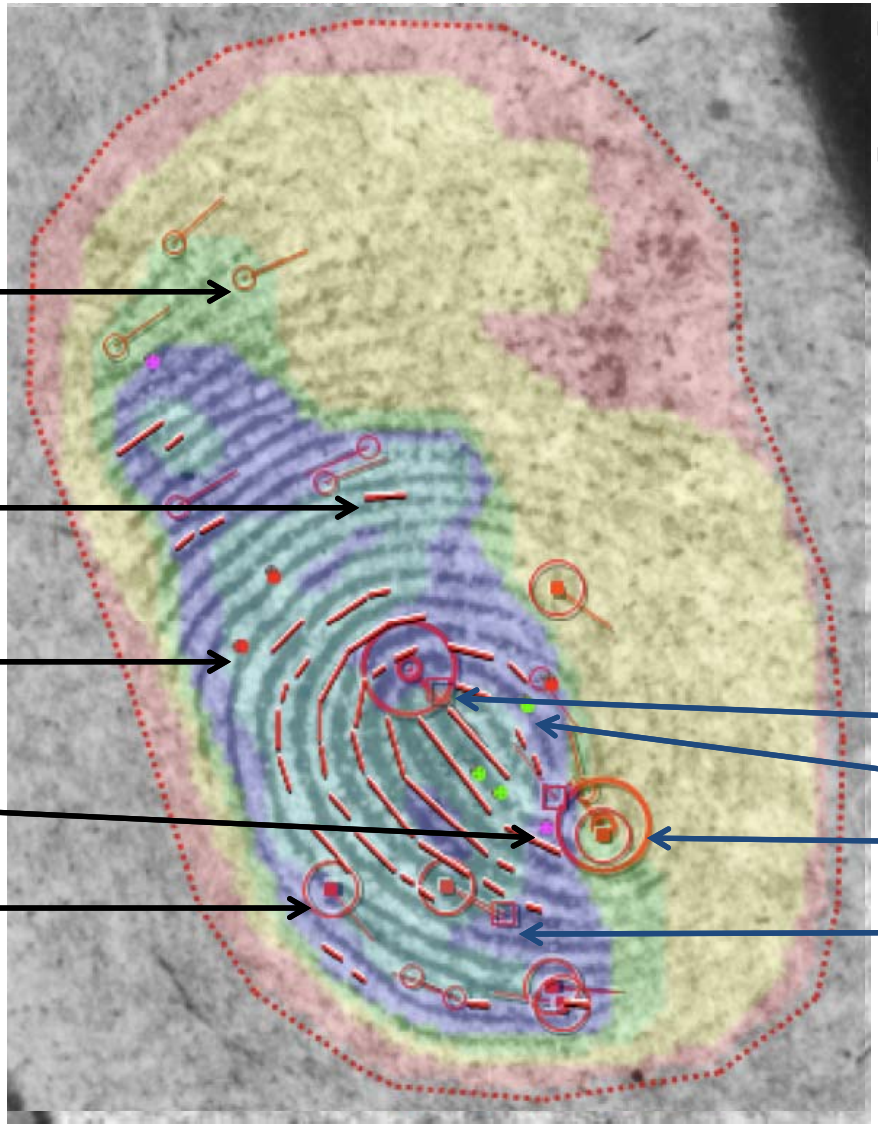
- **Improve ANSI/NIST feature set**
  - Additional features and revised definitions of existing features
  - Extended Feature Sets (EFS) -> ANSI/NIST-ITL 2011
- **Standardize vendor-neutral latent search transactions**
  - Latent Interoperability Transmission Specification (LITS)
  - Based on ANSI/NIST-ITL 2011 EFS features (profiles)
  - Compatible with FBI EBTS v9.3 (NGI)
- **Best Practices for Examiners**
  - EFS Markup Instructions and Reference Data

Extended Feature Set (EFS)



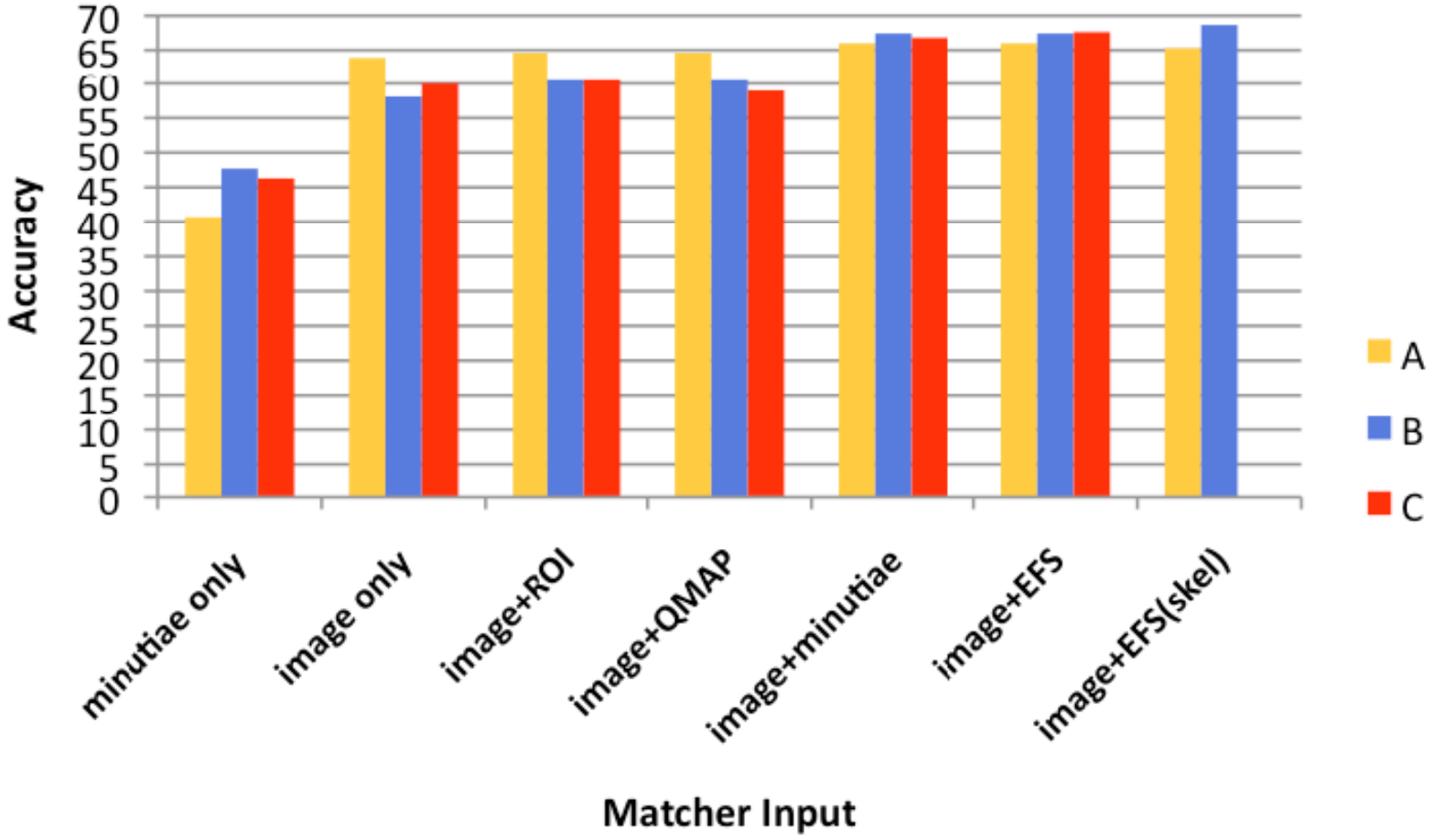
- **Improved Feature Quality**
  - *region quality map*
- **Improved Feature Set:**
  - *endings/bifurcations*
  - *pores*
  - *protrusions*
  - *incipient ridges*
  - *dots*
  - *creases*
  - *scars*
  - *skeleton*

Extended Feature Set (EFS)



- **Improved Feature Quality**
  - *region quality map* (NEW)
- **Improved Feature Set:**
  - *endings/bifurcations*
  - *pores*
  - *protrusions*
  - *incipient ridges* (NEW)
  - *dots*
  - *creases*
  - *scars*
  - *skeleton*

ELFT-EFS Test Results:
Accuracy vs. EFS Feature Subset

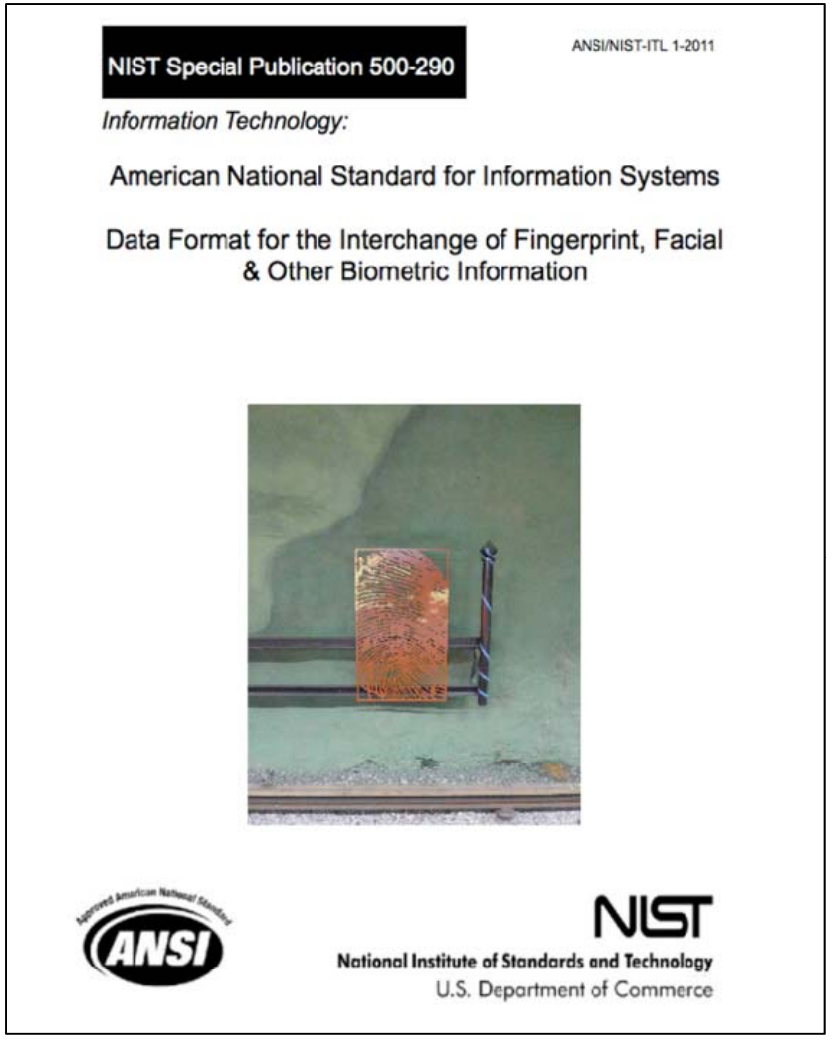


For More Information…

Web ➔ http://fingerprint.nist.gov/latent

Email ➔ sorandi@nist.gov

The ANSI/NIST-ITL Standard



ANSI
American National Standards Institute

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Why use Standards?

- Ensure consistency in data definition
  - Meaning of the data
  - Usefulness of the data
- Transfer relevant information with the biometric sample(s)
- Enable data to be collected and used by different types of systems using systems from multiple vendors (facilitate interoperability)

A Brief History

Original focus:

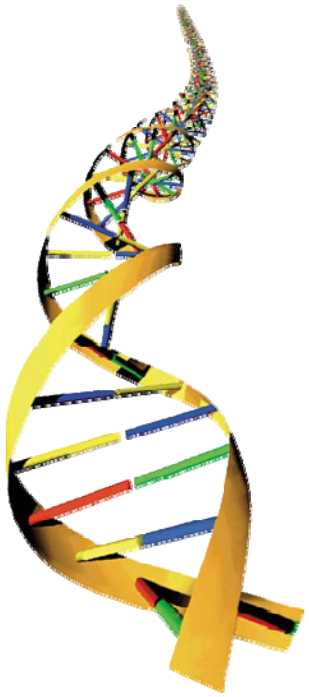
- law enforcement organizations
  - sending fingerprint minutia to the FBI (starting in 1986)
- Expanded to include other law enforcement
  - Military
  - Intelligence
  - Homeland Security
- Expanded in revisions in 1993, 2000, 2007 and 2008 to include other modalities

US-VISIT
Keeping America's Doors Open and Our Nation Secure

Locations Of ANSI/NIST-ITL Installed Systems

Blue: National and International System Use
Red: State / Provincial / Local System Use

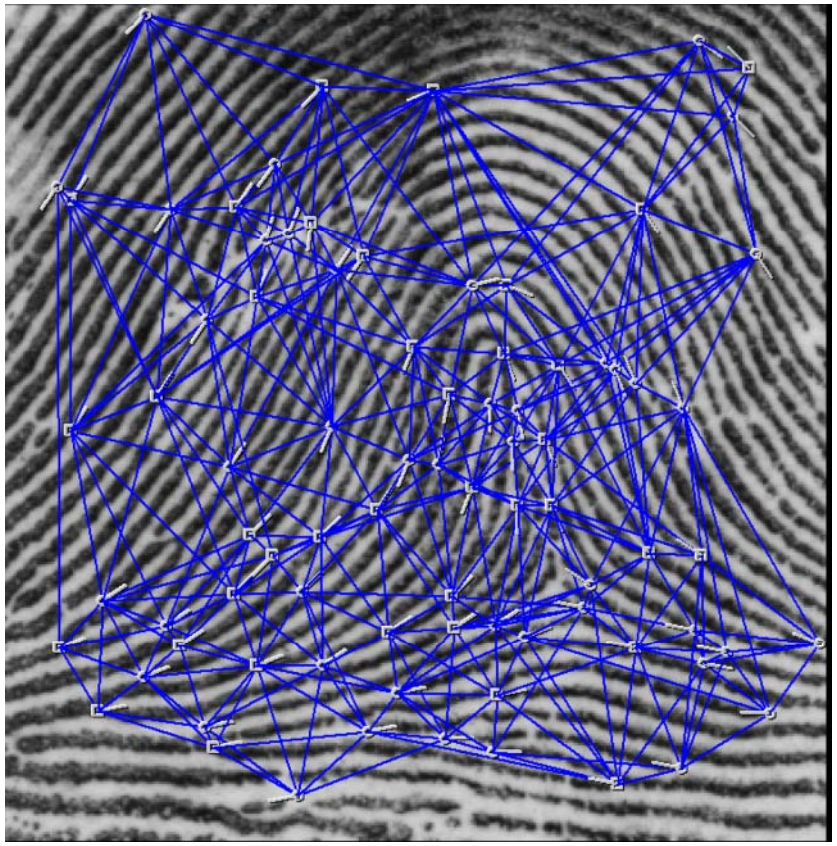
ANSI/NIST-ITL 1-2011



New Modalities

- DNA
- Plantar (Footprint)
- Iris Compact Formats
- Images Of Additional Body Parts (Besides Face)

ANSI/NIST-ITL 1-2011

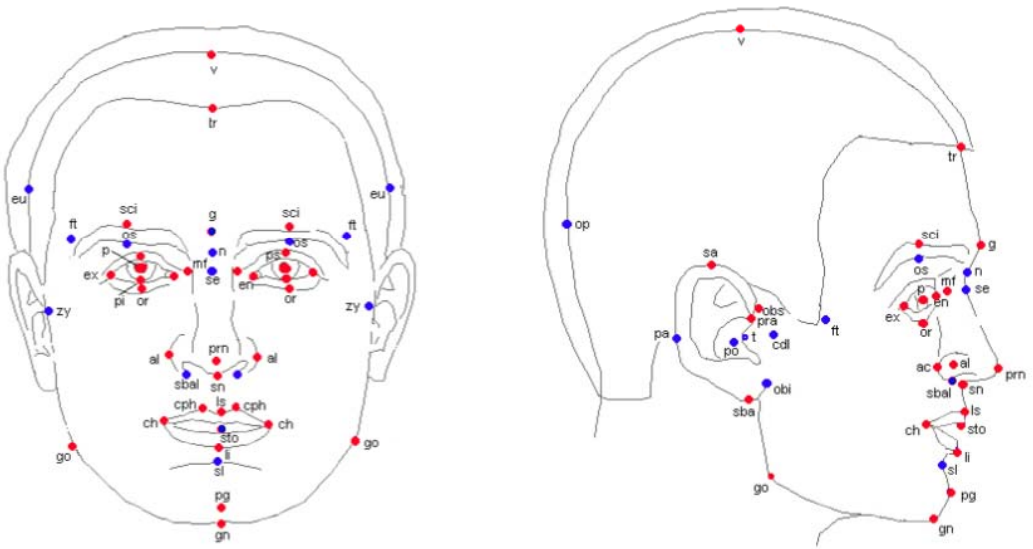


- Latent Friction Ridge Extended Feature Set Markups
  - Cores
  - Deltas
  - Distinctive Characteristics
  - Minutiae
  - Dots
  - Incipient Ridges
  - Creases & Linear Distortions
  - Ridge Edge Features
  - Pores & Ridge Edgefields

ANSI/NIST-ITL 1-2011

Forensics:

- Universal latent workstation automated annotation
- Images of the body (beyond face, iris and friction ridges)
- 3D anthropometric facial image markup fields

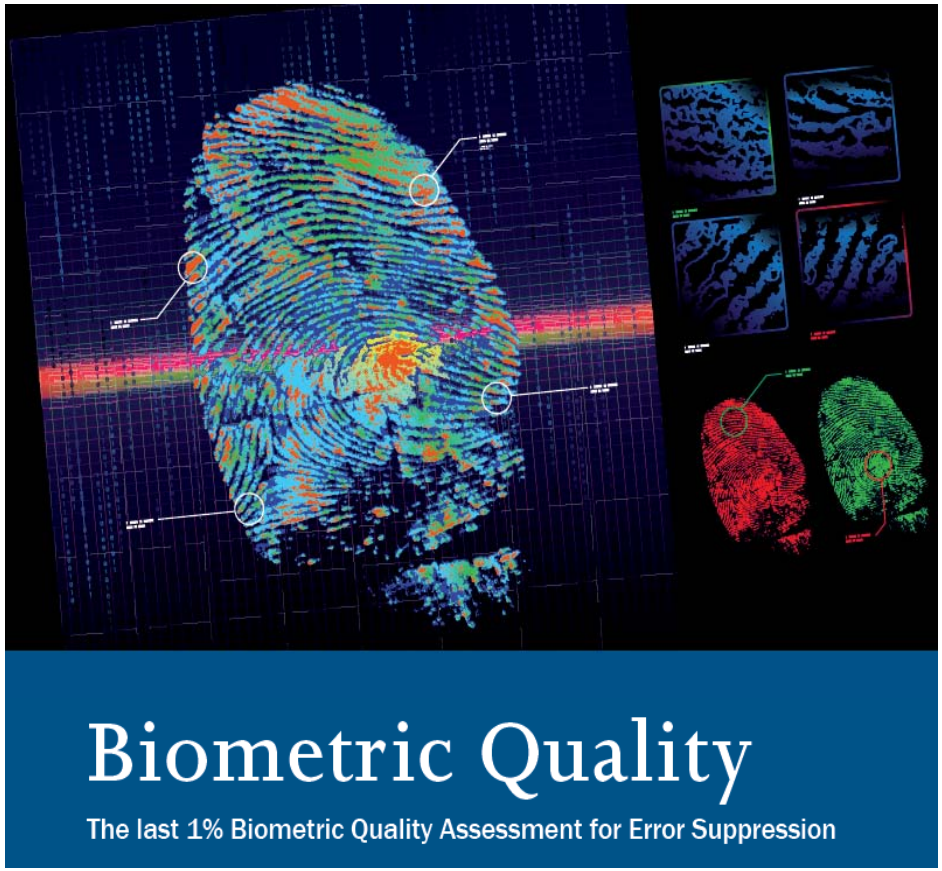


Brad Wing, NIST, Information Technology Laboratory
Brad.Wing@NIST.GOV
301 975 5663

FOR FURTHER INFORMATION:

http://www.nist.gov/itl/iad/ig/ansi_standard.cfm

National Institute of Standards and Technology
U.S. Department of Commerce



Next Generation NFIQ

Elham Tabassi
NIST / ITL / Image Group

Back in 2004 …

NIST Fingerprint Image Quality (NFIQ 1.0)

- NIST developed NFIQ in 2004
  - Open source, publicly available
- Key innovation: quality as a rank statistic for performance
- NFIQ is a machine learning algorithm
  - Exploratory variables: image properties (minutiae, ridge clarity)
  - Response variable: separation of genuine and impostor comparison

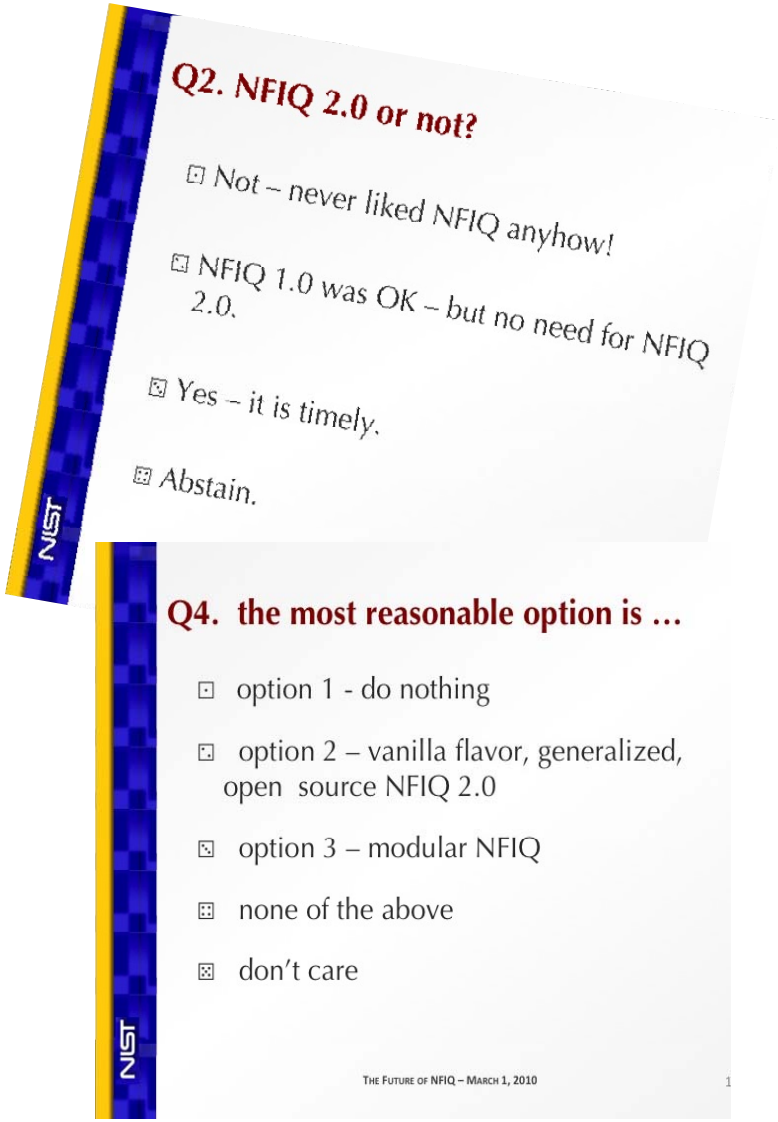
Breaking the myths of biometric quality

- Quality is not about human perception
  - It is about why recognition algorithms fail
    - Scientific research to quantify
      - the effect of image covariates on recognition error (FNMR and FMR)
      - Whether, to what degree and for which covariates constancy (or sameness) matters.

- Quality *does not* come in pairs
  - comparison scores come in pairs!!
    - Quality algorithm is not needed if the pair of images to be compared are available -- use a matching algorithm
    - Most of the time (e.g., enrollment) only one instance (representation/view/..) is available
      - This is one of the reasons why the quality problem is challenging
    - A very poor quality sample almost always causes recognition failure, regardless of quality of the other image

Workshop on March 6, 2010 (IBPC 2010)

- Several options for NFIQ 2.0 were discussed
  - http://biometrics.nist.gov/cs_links/ibpc2010/options_for_NFIQ2.0.pdf
- The community overwhelmingly recommended a new, open source, generalized version of NFIQ to be developed in consultation and collaboration with users and industry.
  - Same technical approach, but better, bigger, faster, etc.



NFIQ 2.0

- Generalized vanilla flavor
  - More levels, particularly for poorer quality
- Improve feature vector
  - A *standardized* vector of quality scores?
- Faster to meet requirements of mobile application (< 15 msec)
- Calibration
  - And mapping to NFIQ 1.0
- Slap quality
  - Not just aggregate of the 4 fingers
  - How to handle missing fingers
- Technical guidance for setting quality threshold
  - Enrollment and verification
- Less dependencies of makefiles / libraries + better documentation

NFIQ 2.0 Team

- NIST and BSI teamed up to develop the new and improved open source NIST Finger Image Quality.
- Invited research organizations and industry members to provide specific support in the development of NFIQ 2.0.
- Suggestions/comments to nfiq2 DOT development AT nist DOT gov
- Website

  http://www.nist.gov/itl/iad/ig/development_nfiq_2.cfm

Call for participation

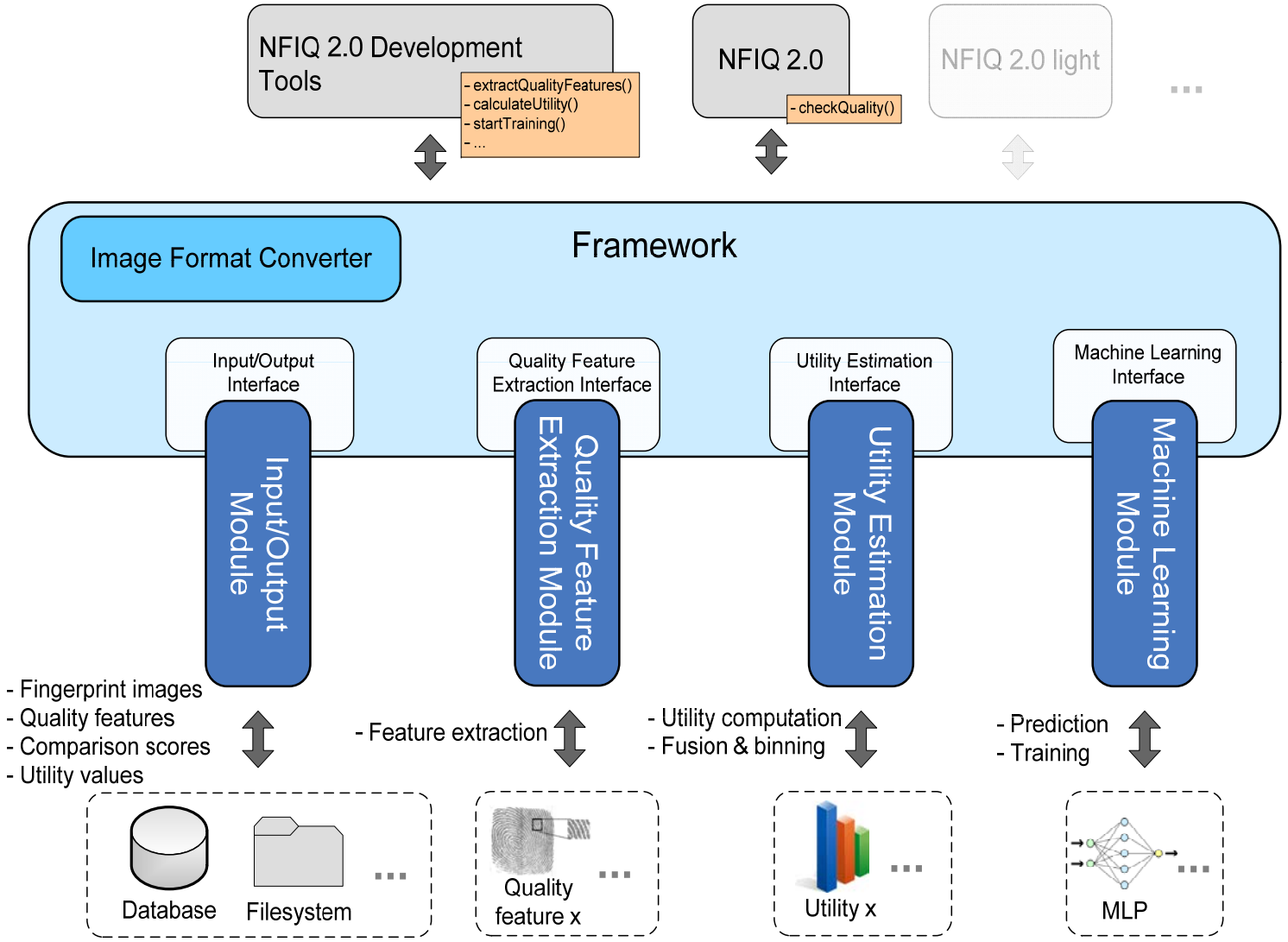
- Submission of comparison subsystems (i.e. matchers) whose comparison scores will be used for training of NFIQ 2.0
  - 9 participants (major fingerprint recognition technology providers)
- Submission of fingerprint images demonstrating NFIQ 1.0 anomaly

Out of scope of NFIQ 2.0

i.e., When NOT to use NFIQ 2.0

- Latent fingerprints -- while same approach works, it is a very different problem than finger image
- 1000 ppi (not enough images around)
- Images captured by non-optical sensors

Architecture of NFIQ 2.0 Framework



Design principles / Development fields

feature extraction

- Selection of features (Measure appropriate image characteristics that convey information for comparison algorithms)
- Number of features
- Implementation issues :: speed / robustness / etc.

machine learning

- Selection of training data (balanced mixed of easy / moderate / difficult)
- Selection of utility function (response variable)
- Techniques (SVM, Regression tree, MLP, etc.)
- Training parameters

NFIQ 2.0

- Fingerprint or not? Altered fingerprint or not?
- “Lite“ version
- Vanilla flavor + Several algorithmic flavours
- Modular design

Current Quality Feature Groups

- Group 1: NFIQ1.0
  - Quality Zone 3+4, Foreground
- Group 2: Implemented from ISO/IEC TR 29794-4
  - Frequency Domain Analysis
  - Local Clarity Score
  - Orientation Certainty Level
  - Orientation Flow
  - Radial Power Spectrum
  - Ridge Valley Uniformity
- Group 3: New Features
  - Gabor (Olsen, 2012), Gabor (Shen et al., 2001)
  - Minutiae count, mean pixel intensity (input image, block wise), sigma of intensity
- Group 4: Open Source Contribution
  - Digital Persona JetFX Minutia Extractor Derivate" (e.g. total # of minutiae)
  - Your contribution ?

```
function [orientationCertaintyLevel] =
         compOcl(im, maskim, v1sz, blksz)
    allfun = inline('all(x(:))');
    [rows cols] = size(im);
    eblksz = ceil(sqrt(sum(v1sz.^2)));
    blkoffset = ceil((eblksz - blksz)/2);
    mapsize = fix(([rows cols] - (eblksz –
              blksz))./blksz);
    maskBseg = false(mapsize);

    ocls = zeros(mapsize);
    br = 1; bc = 1; % invariants
    for r = blkoffset+1:blksz:rows-
            (blksz+blkoffset-1)
        for c = blkoffset+1:blksz:cols-
                (blksz+blkoffset-1)
            blkim = im(r:r+blksz-1,
                    c:c+blksz-1);
            maskB1 = maskim(r:r+blksz-1,
                     c:c+blksz-1);
            maskBseg(br,bc) = allfun(maskB1);
            [cova covb covc] = covcoef(blkim);
            ocls(br,bc) = ocl(cova, covb,
                              covc);
            bc = bc+1;
        end
        br = br+1; bc = 1;
    end
    ocls(not(maskBseg)) = NaN; % mask bckgrnd
    orientationCertaintyLevel =
                      mean(ocls(~isnan(ocls)));
end
```

Current Status

- ✓ Framework design complete
- ✓ Framework implementation complete
- ✓ Feature selection based on their influence on recognition performance and computational efficiency
- ✓ Feature evaluation by correlation and ERC curves (Error-Reject-Characteristics)
- ✓ Steps towards machine learning procedure
  - ✓ Definition of response variable based on comparison scores
  - ✓ Training set selection

We like to hear your thoughts /comments / suggestions

Standardized Features?

Vector of quality components

- Revision of ISO/IEC 29794-4
- Follow the Part 6 (iris quality) model
  - For each quality component: Specify definition (what it is), computation method, measurement unit, threshold/valid range

Allows for

- Plug-and-play of features
  - for implementations that satisfy semantic conformance to the requirements of the standard
- Actionable quality
  - constructive feedback
  - mitigation

For public review / open source

http://www.nist.gov/itl/iad/ig/development_nfiq_2.cfm

Documents

- NFIQ 2.0 Framework
- Quality feature definitions
- Quality feature evaluation
- Training data composition
- Utility function
- Summary of March 5, 2012 workshop

Source code

- Framework
- Feature computation (most are Matlab prototype now)

National Institute of Standards and Technology
U.S. Department of Commerce

Team Members

- NIST (US)
- Federal Office for Information Security (BSI)
- BKA
- Fraunhofer IGD
- Hochschule Darmstadt /
- Security Networks AG
- *...and the whole biometrics community*

Sponsors

Homeland Security
Science and Technology

DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF INVESTIGATION

Elham Tabassi
tabassi@nist.gov

www.nist.gov/itl/iad/ig/development_nfiq_2.cfm
nfiq2 DOT development AT nist DOT gov

To join NFIQ2.0 mailing list, email tabassi AT nist DOT gov

Fingerprint Compression and Next Generation Fingerprints

Shahram Orandi

Background info... What is compression?

⇨ A method of encoding information in a way that it uses fewer bits than the original representation, and thereby becomes smaller in size when **stored** or **transmitted**.

i.e., your DNA can store 3.4 Zettabytes of data in 1 gram.

1 gram = 3.4 Zettabytes
(3,400,000,000,000,000,000,000 bytes)

Library of congress = 0.000,000,010 Zettabyte
(10 terabytes)

Two types of compression: Lossy and Lossless

Lossy

10% of original, but never back to the way it originally was. Some detail is lost in the process. We can control how much detail we're willing to lose in return for a smaller image.

Lossless

50% of original, but can perfectly reconstruct the original image. No detail is lost in the process.

How is compression used on fingerprints in the United States?

Lossy compression is used for normal 10-print imagery (fingerprints collected in controlled and/or guided circumstances). Since this type of print forms the bulk of data being operated on daily this type of fingerprint results in the largest impact in data storage and transmission resources.

Lossless compression is used for latent imagery (fingerprints left behind at a crime scene). These images typically start with far worse quality due to uncontrolled capture, so maximal fidelity is needed to preserve any and all details.

In 1994 The IAI & FBI conducted a study.

The goal of this study was to determine how much detail loss was acceptable in the lossy compression of fingerprints while maintaining their usability for the intended task.

This study was the basis for the 15-to-1 compression target ratio using the WSQ CODEC for 500 ppi fingerprint imagery in the United States and many places throughout the world.

In 2010 NIST & FBI conducted a new study to build a basis for 1000 ppi fingerprint imagery using JPEG-2000.

Compression Study Summary of Findings So Far:

(Published) NISTIR 7778: Showed that given the same criteria as the 1994 IAI study, the more specialized WSQ CODEC performs better on fingerprint imagery than JPEG-2000 therefore a less aggressive compression performance target may be more appropriate for JPEG-2000 with 1000 ppi imagery to place it on equal behavior footing with WSQ.

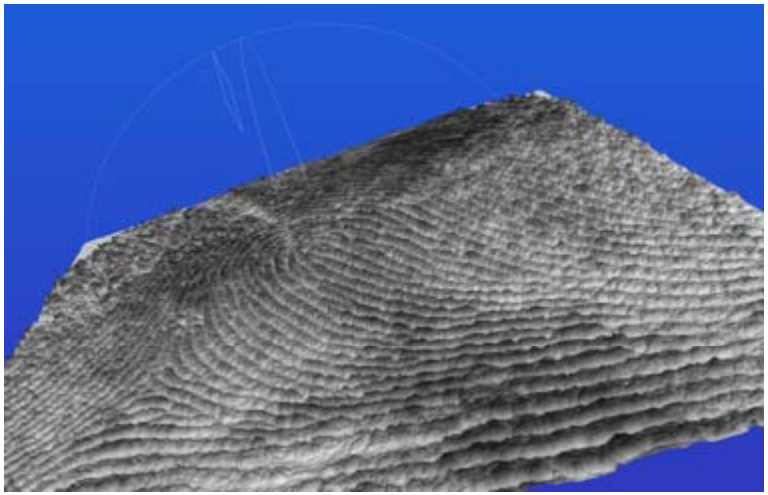
(Published) NISTIR 7779: Showed that JPEG-2000 when operated in a lossless mode can generally outperform non-wavelet based CODECs (i.e., PNG) in terms of compression effectiveness. Non-wavelet based CODECs on the other hand lead in terms of throughput performance.

(Published) NISTIR 7781: Showed that JPEG-2000 proves to be quite stable over multiple successive compression passes. It also showed that careful consideration must be made to cases of multiple compression with mixed CODECs (i.e., WSQ on an image already compressed with JPEG-2000) as these cases appear to incur the most impact to the image.

(Published) NISTIR 7839: Showed that in down-sampling of 1000ppi fingerprint imagery to 500ppi for legacy system interoperability, Gaussian filters excel in the area of perceived quality by professional examiners while non-Gaussian filters may provide an edge in throughput performance.

(ETA 2013) Special Publication 500-289: Provides a comprehensive guidance for the compression of 1000ppi friction ridge imagery.

Next Generation Fingerprints:
3D/Contactless Capture



3D/contactless capture has many challenges

The biggest challenges are repeatability and fidelity to the original sample.

In partnership with DHS S&T set out in 2009 to create a test target that can be loaded into a contactless scanner and imaged.

Goals for the Artifact:

- To build an artifact with known geometric attributes that can be presented to the contactless scanner for imaging.

- The captured image can then be used to compare to the original artifact to establish fidelity and repeatability, and measure error.

Not a goal for the Artifact:

- To build a finger.

Secondary challenges for this target include:

- Mechanical Stability
- Thermal Stability: structural and optical
- Contrast: Optical and 3D... Something to lock on to
- Reproducible: ...in a “reasonably” automated fashion.
- Timely and Achievable: ... “reasonable” time & effort
- Reasonable Cost: Can we get there for $3k?
- Simple design: Simple to build, simple to measure.
- Safe and non-toxic: safe for human handling, “GRAS” (Generally Recognized As Safe”)

In 2011 we completed a set of 3 targets:

A dot pattern target: To facilitate testing of scanner's ability to capture details such as a minutiae.

A line/grid target: To facilitate testing of a scanner's ability to capture details such as a fingerprint ridge.

A gradient pattern: To facilitate testing of a scanner's capture-resolution capability.

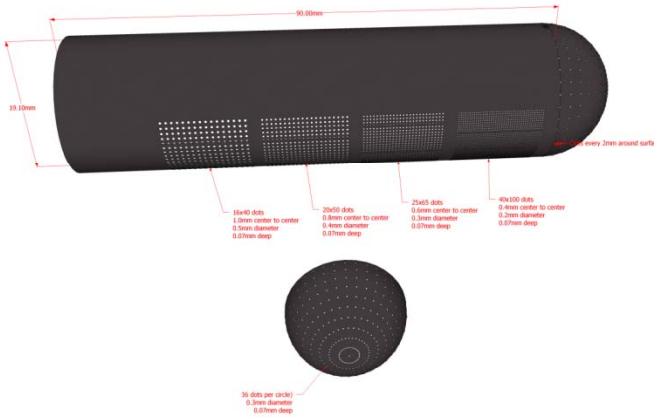
Dot pattern

aka ‘Minutiae target’

Provides a simple grid-dot pattern.

Smallest pattern area dots approximate the size of typical ridge endings.

Tip provides simple radial dot pattern design with fixed angle stepping (w.r.t. cylinder axis).



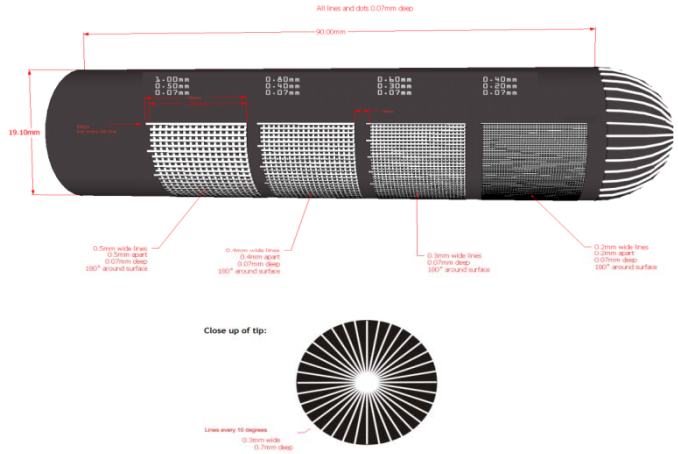
Line pattern

aka ‘Ridge target’

Provides a simple grid-line pattern.

Smallest pattern area lines approximate the width of typical ridge structure.

Tip provides simple radial line pattern design with fixed angle stepping (w.r.t. cylinder axis).



Resolution pattern

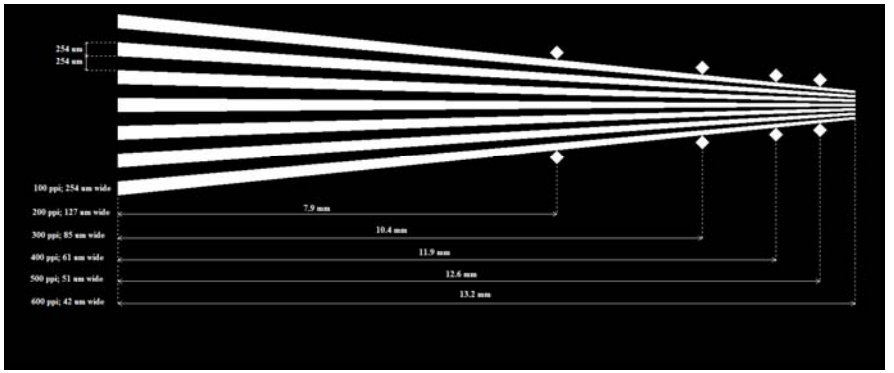
Establish/verify sampling resolution of imaging device.

Has 3D pattern sufficient to test up to 600dpi.

Still in manufacturing refinement phase.

Lots of TBD's (CTF/MTF, is 2D projection sampling rate the same as 3D sampling rate?)

More difficult to manufacture than expected (finest features are ½ as wide as a human hair)



Where to...

...from here

- Everything is pivotal on the devices as they ready for market.
- 3D to 2D remains a huge problem. Academia has lead on this right now.
- We will continue to support the research community (free software, loaner targets) while devices emerge.

Fingerprint Vendor Technology Evaluation 2012

Craig Watson

Image Group, Information Access Division,
National Institute of Standards and Technology
US Department of Commerce

WWW.NIST.GOV/ITL/IAD/IG/FPVTE2012.CFM OR GOOGLE "FPVTE 2012"

What is FpVTE2012?

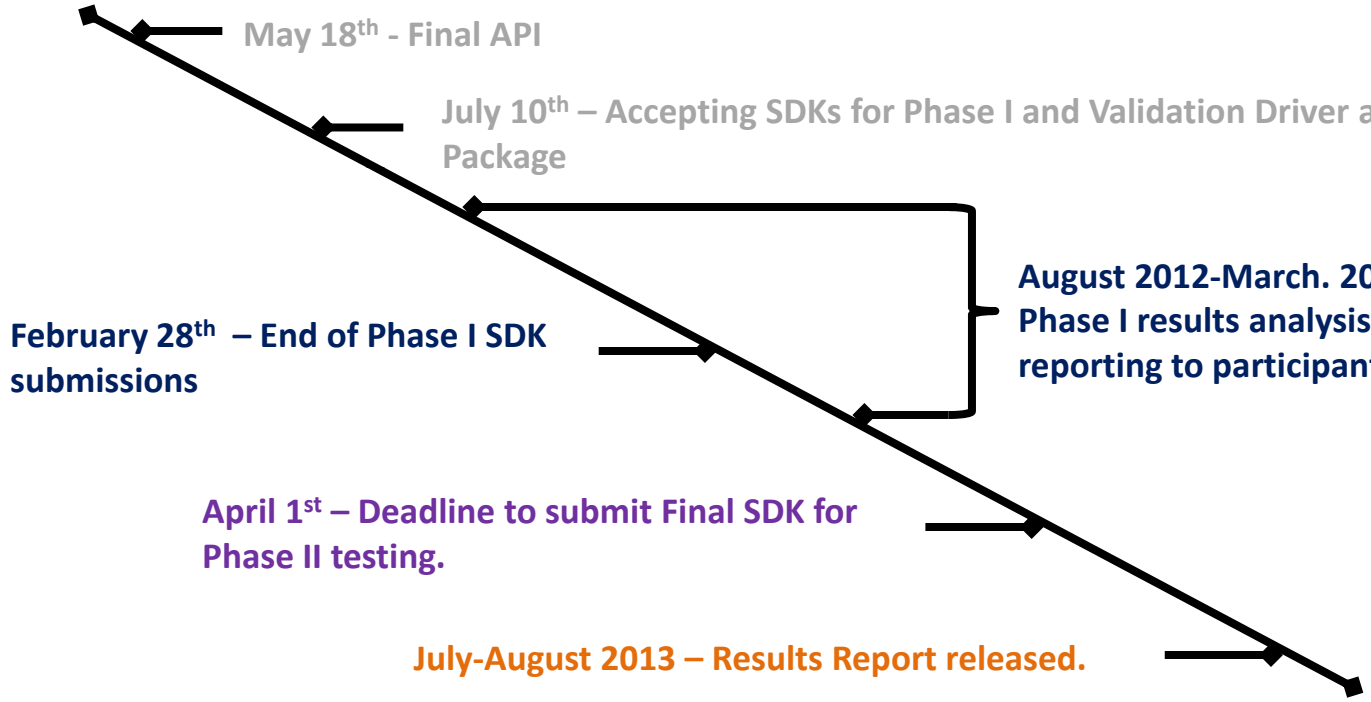
- **Evaluation of 1-to-many fingerprint matching technologies**
- **Use enrollment sets up to several million subjects**
  - **Sequestered Operational Data**
- **A software test run using NIST owned hardware**
- **It is not intended to evaluate an end-to-end Automated Fingerprint Identification System.**
  - **NIST API controls how software configured for the test**
  - **Multi-threading is not allowed**
  - **First pass with a two-stage matching API**

Why FpVTE2012?

- **Assess the current accuracy of one-to-many fingerprint matching using operational data. Last test FpVTE2003.**
- **Provide testing framework and API for enrollment sizes that spread across the memory of multiple blades.**
- **Support U.S. Government sponsors in future biometrics assessments and analysis with an API and testing framework that can be applied to other biometrics.**
- **Evaluate operational datasets that contain Identification Flats, single finger plain, and ten print rolled and plain captures.**

Fingerprint Vendor Technology Evaluation 2012

Important Dates

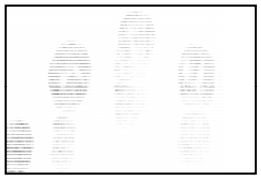


Fingerprint Vendor Technology Evaluation 2012

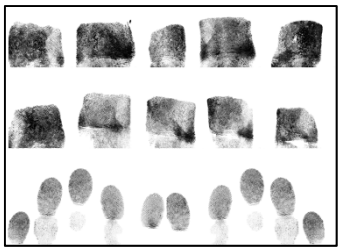
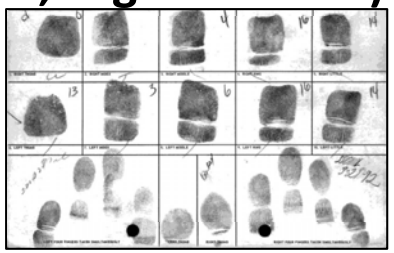
Testing Scenarios

- Class A: Single finger captures (no segmentation)

- Class B: A + ID Flats (4-4-2, segmentation required)



- Class C: A + B + Roll and Plain capture (4-4-1-1, segmentation)

Participation Options	Class A Two Finger	Class B ID Flats	Class C 10 Roll and Plain
1	X		
2	X	X	
3	X	X	X

Operational Datasets

- **Class A - DHS-POE, BVA - (~23 million, 2f, L/R index) – Captured 2004 - 2008**
- **Class B - DHS and FBI - (~3.5 million, 10f, 4-4-2) – Captured 2007 - 2008**
- **Class C - DHSBEN, FBI, LACNTY, TXDPS, & AZDPS - (~5.5 million, 10f, roll, 4-4-1-1)**

Class	Data Set Type	Search Data	Search Subject Size	Enrollment Data	Enrolled Subject Sizes
A	Single plain capture	1f right or left index 2f right & left index	200K mates 400K non-mates	1f plain capture 2f plain capture	5K, 10K, 100K 10K, 100K, 500K, 1.6M
B	Identification Flats	10f plain (4-4-2) 8f right and left slap 4f right or left slap	200K mates 400K non-mates	10f plain (4-4-2)	500K, 1.6M, 3M
C	Ten print capture	10f rolled 10f plain (4-4-1-1)	200K mates 400K non-mates	10f rolled 10f plain (4-4-1-1)	500K, 1.6M, 3M, 5M

Computational Requirements

(Per SDK)

Class	Data Set Type	# Single Finger Enrollments	# Search (PhaseI)	# Search (Phase II) planned	Enrolled Subject Sizes
A	Single plain capture	8,832,000	90,000	1,800,000	5K, 10K, 100K 10K, 100K, 500K, 1.6M
B	Identification Flats	93,990,000	120,000	2,400,000	500K, 1.6M, 3M
C	Ten print capture	112,500,000	90,000	1,800,000	500K, 1.6M, 3M, 5M

Current Participation Status

- **22 Applications accepted (2 Withdrawals)**
  - **Class A only - 3**
  - **Class A, B, and C – 17**
  - **Nine countries**
  - **Mix of "Normal" participants and new/unknowns**

- **Software submitted as of 02/22/2013**
  - **Class A – 39 submissions from 20 participants**
  - **Class B – 30 submissions from 17 participants**
  - **Class C – 28 submissions from 17 participants**

- **Each Participant can submit**
  - **Phase I – Two "fast" and two "slow" SDKs for each class.**
  - **Phase II – One final "fast" and one "slow" SDK for each class.**

NIST Driver Software

- **RecordStore for data input**
  - **Database storage of input records and output templates (BerkeleyDB) for fast storage and retrieval.**

- **Message Passing Interface (MPI)**
  - **Used to spread work load across multiple cores and multiple blades**
  - **Driver sends work in asynchronous "chunks"**

- **Identification done in two stages**
  - **Stage One – Enrollment set distributed across multiple blades. Each "piece" of enrollment set searched independent of the others.**
  - **Stage Two – Take results from Stage One and return final candidate list with a matching confidence score.**
  - **But algorithm can do multi-pass within one NIST stage**

Core Analysis Results

- Timing for Template Creation
- Template Size
- Search Times and Matching Performance
  - Accuracy vs. Speed
  - Accuracy vs. Enrolled population size
  - Accuracy vs. Number of fingers
  - Speed vs. Enrolled population size
  - Speed vs. Number of fingers
- Fingerprint Template Aging?
- Other?

Future Work

- Failure Analysis
- Additional Result Analysis
  - Fingerprint image quality
  - Zoology
  - Modality comparison
  - Newer ID-Flat dataset for Phase II?
- API/Driver Improvements
  - Participant feedback on improvements
  - Error control and reporting
  - Common Scoring/Results Software
- FpVTE ID-Flat dataset tested on the operational IDENT system?

Other NIST Fingerprint Activities

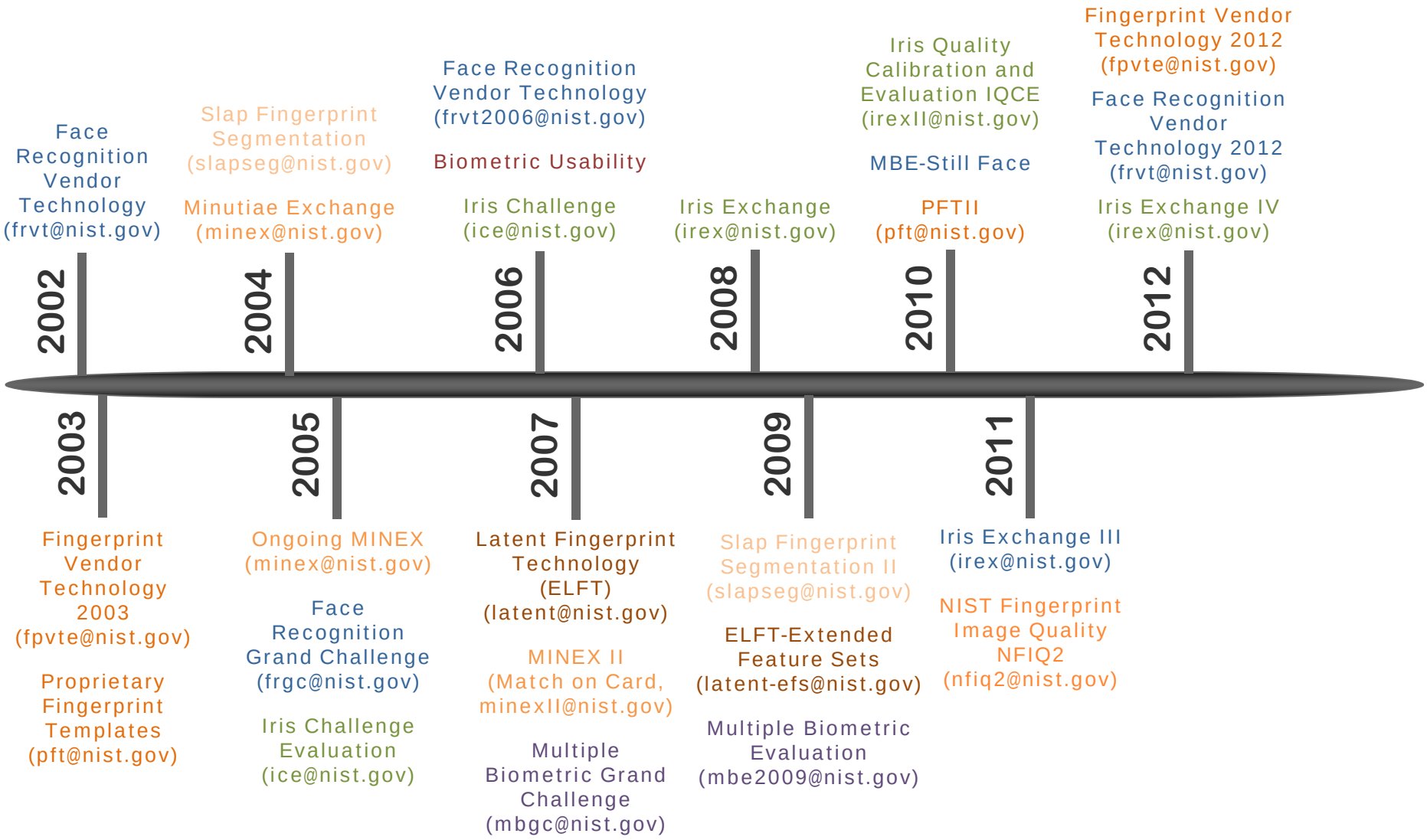
- **PFTII – 1-to-1 Proprietary Fingerprint Matching**
  www.nist.gov/itl/iad/ig/pft.cfm

- **MINEX – 1-to-1 Interoperable Fingerprint Matching**
  www.nist.gov/itl/iad/ig/minex.cfm

- **SlapSegII – Fingerprint Segmentation**
  www.nist.gov/itl/iad/ig/slapseg.cfm

Biometrics Evaluations at NIST

biometrics.nist.gov/evaluations



Questions?

craig.watson@nist.gov

WWW.NIST.GOV/ITL/IAD/IG/FPVTE2012.CFM

GOOGLE "FPVTE 2012"